Technical Report # 1

From: The Crawford Hill VHF Club
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Subject: Circular Polarization for EME Communication

Faraday rotation of linearly polarized EME (Earth-Moon-Earth) signals can produce deep fades in the receiver-detector output, which vary over considerable range in periodicity. (See Technical Report # 20) The periodicity of polarization rotation under enhanced conditions can, at low VHF (144 mc/s), be as short as a second or less and can cause additional difficulties in reception of EME CW or modulated signals. The effect diminishes gradually with increasing frequency until about 3000 to 4000 mc/s where it is virtually non-existent.

The slowing down of the fading rate with increasing frequency can be particularly annoying at, -.For examp1e,- 1296_ mc/s _where a Period .can be measured in tens of minutes.
Under these Conditions an EME signal may remain essentially-cross polarized, and consequently undetectable or very weak, for some time in a linearly polarized system.

Linear polarization control has been used (currently used on 432 mc/s) by physically (or electrically) rotating the antenna polarization orientation to off-set the Faraday rotation. Such a scheme introduces an additional variable for the operator to adjust and manage because Faraday rotation is a non-reciprocal process in nature. This means that the correct alignment of antenna polarization for one direction of the same EME path is not necessarily correct for the reverse path.

For rotation periodicities of around a few seconds, this scheme is unmanageable without sophisticated control.
Fortunately the fading caused by Faraday rotation ref linearly polarized transmission can be virtually eliminated by simply employing circular polarization exclusively for EME Communication.

The purpose of this report is then to urge and recommend that ALL EME communication be carried out with circular
Polarization. Even at microwave frequencies where Faraday rotation is not a problem, there is still a linear polarization time dependent tracking problem due simply to the geometry of the EME path. **

In addition to the above benefits, circular polarization offers the unique property that if a convention of ALWAYS using RIGHT circular polarization on transmit And LEFT circular polarization on receive is adopted, then all EME stations will be compatible with each other for two-way communication, AND for echo testing. This is so because reflection of a circularly, polarized Wave Also reverses the sense of polarization, whether it be off the Moon or any reflecting Process. In reflector antennas the feed antenna sense must therefore be opposite to the ultimate radiated sense required.

Another benefit which is very valuable to an EME system is that the two senses, right and left circular, are in nature uncoupled modes of transmission. This means that a radiating system, antenna, may radiate each sense independently. Theoretically then, it is possible to construct a single antenna system with two ports (connections), one for left and one for right circular

polarization, which are physically and electrically independent. In practice, electrical isolation between the ports of - 20 db can be achieved readily and higher isolation can be achieved by careful electrical balancing (nulling out) at one frequency.

The implication of this feature is that the transmitter may be permanently connected to one port with no need for switching at high r-f levels, and with reduced losses; while the receiver preamp may be connected to the opposite sense port with a overload protection (crowbar) of modest requirements, again minimizing losses at the antenna-preamp interface where reducing losses is most beneficial to the overall operating system noise temperature. (See Tech. Report # 3 and # 11) See also Tech. Rept. # 5 on limitations of port isolation for a front fed parabolic reflector antenna. See Tech. Rept. # 18 for an improved off-set fed reflector antenna system which has no limitation on port: isolation.

Elimination of Faraday fading and of the need for a high-power T-R switch, as well as eliminating the need for linear polarization tracking and adjustment, surely justifies the use of circular polarization.
Reports # 2 and # 9 describe hardware methods of implementing circular polarization for an EME system.

** "Polarization of an Az-E1 Mounted Antenna Viewing Celestial Objects", IEEE Transactions on Antennas and Propagation, September, 1966, p. 650.